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Improved Terrain Generation From UAV Sensors

Baer, Wolfgang

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Improved Terrain Generation From UAV Sensors

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By

Wolfgang Baer

Associate Research Prof. Naval Postgraduate School

Monterey, California Baer@nps.edu

Nascent Systems

Improved Terrain Generation From UAV Sensors

- Image-Model Feedback Algorithm for Rapid Terrain Database Generation
  - Dual eye input registration aid
  - Interactive Registration Algorithm
- PVNT Mission Control Station
- Image Registration Bottleneck
- Dual Eye Input Experiments

Rapid Terrain Database Generation using the Image Feedback Algorithm

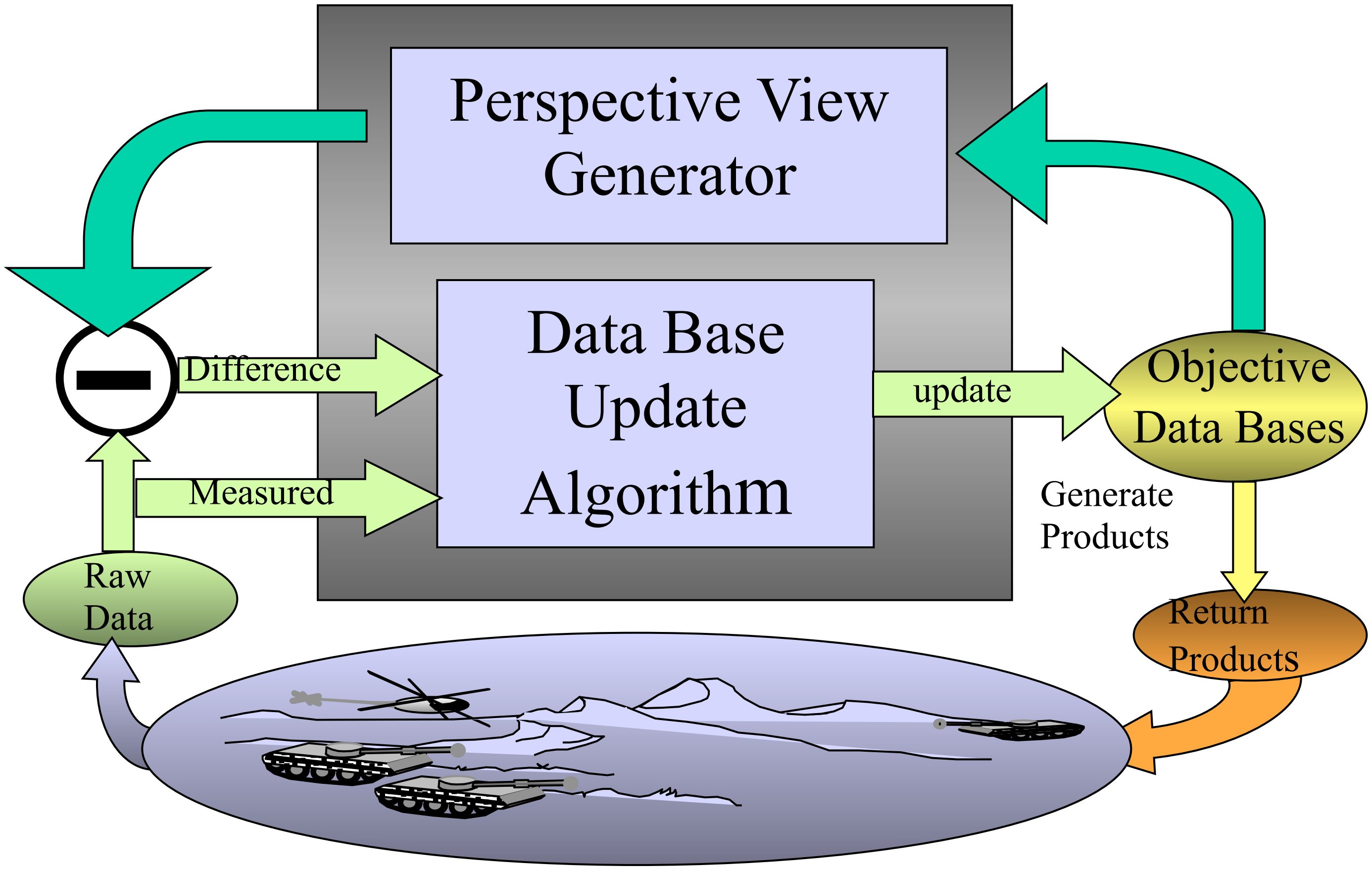


Fig. 1. Block diagram of Model-Image Feedback Algorithm

Advantage of Image-Model Feedback Algorithm

- It is easier to generate accurate perspective views from 3D models than to perform pattern recognition on 2D images in order to generate 3D models.
- Examples are
  - Shadow effects
  - Haze and atmospheric effects
  - Local feature heights
  - Foreshortening and perspective distortions

Importance of Shadows

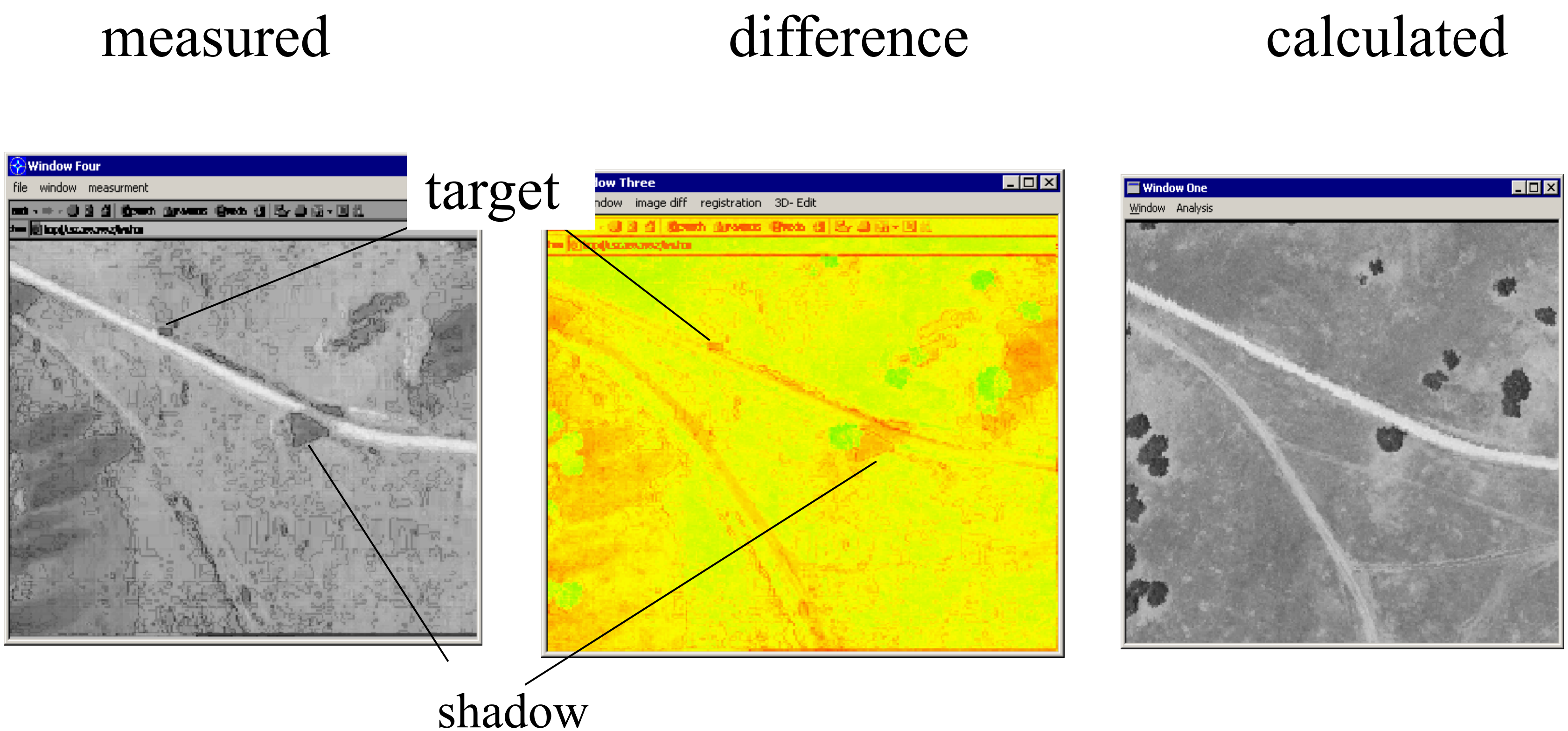
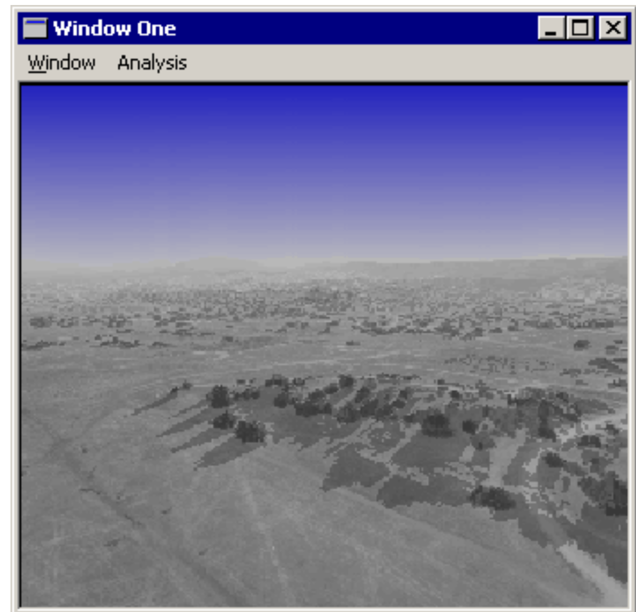


Fig. 3. Shadow Example Comparisons from UAV flights during TNT 06-2

Atmospheric Effects Shadows And Haze



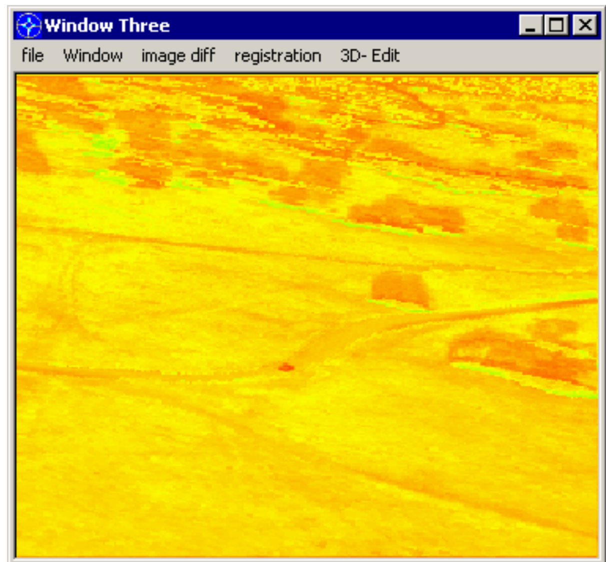
No Shadow Shadow and Haze Effects

Fig. 4. Shadow and surface haze correction in calculated PVNT reference images

Local Feature Heights

Measured

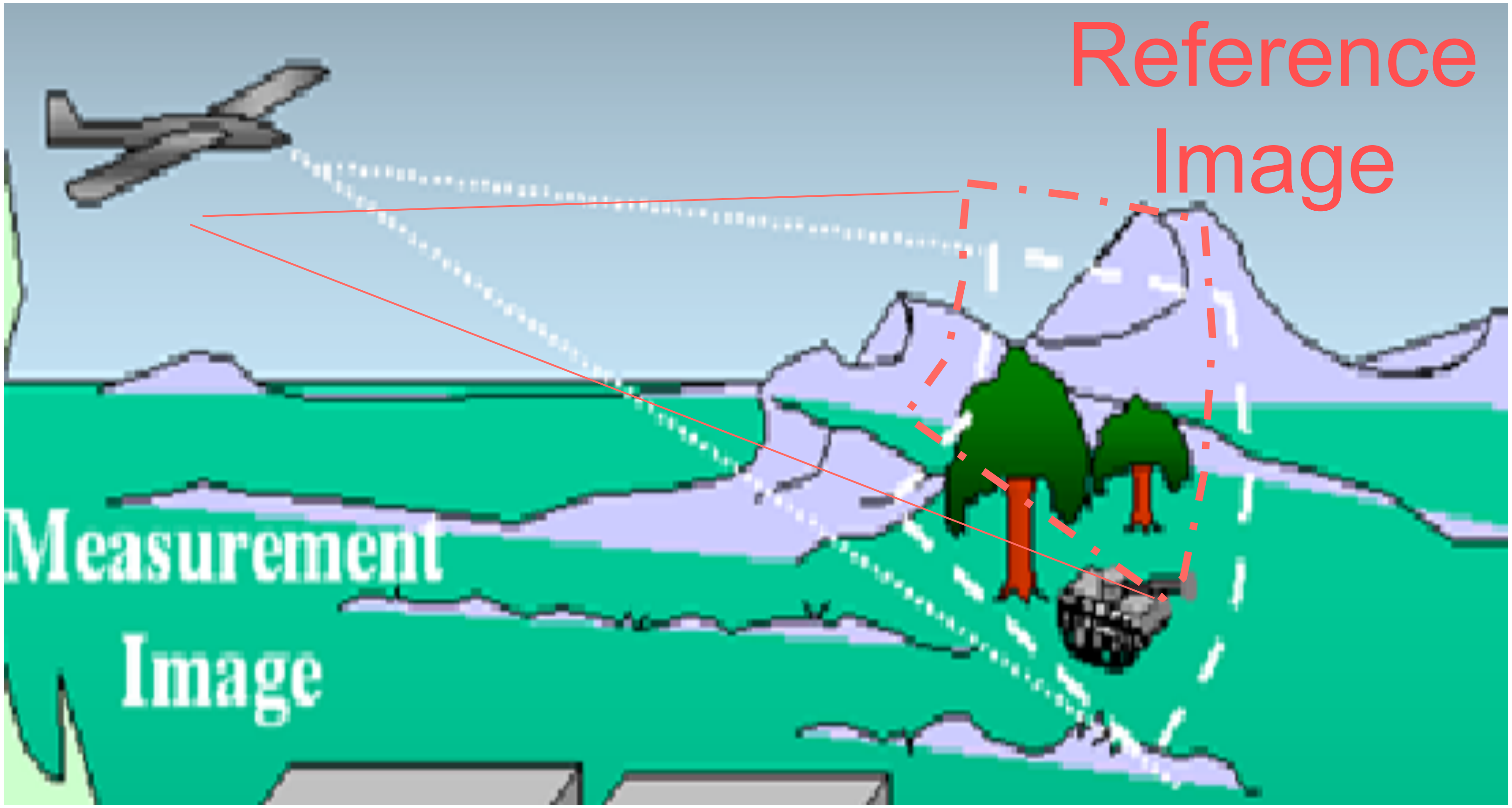
Difference



Calculated

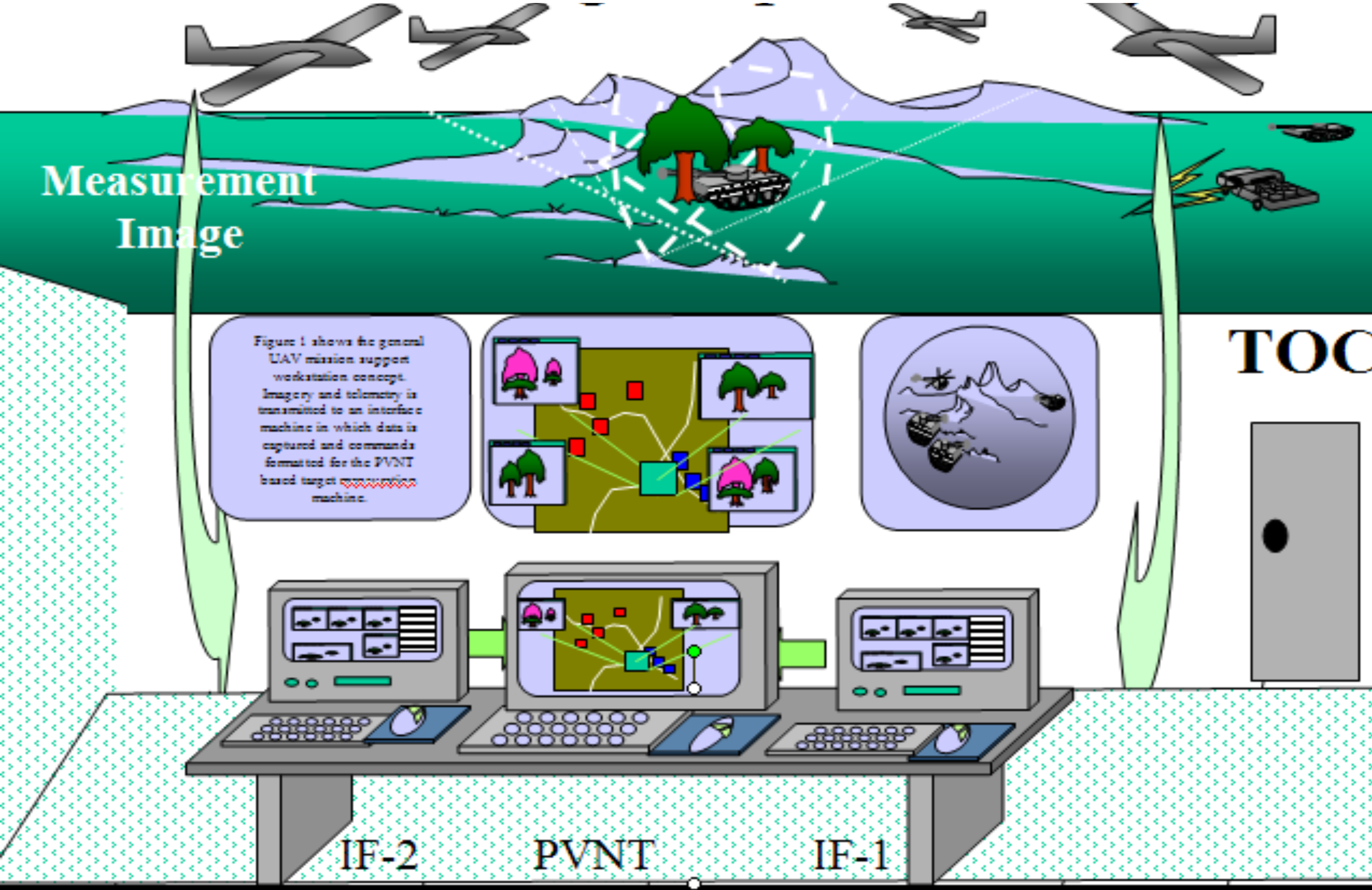
Local feature heights are required both for shadow calculation and to avoid the flat look when comparing actual with oblique views generated from draped data bases such as Google Earth

Automatic Aspect Angle and Foreshortening Correction

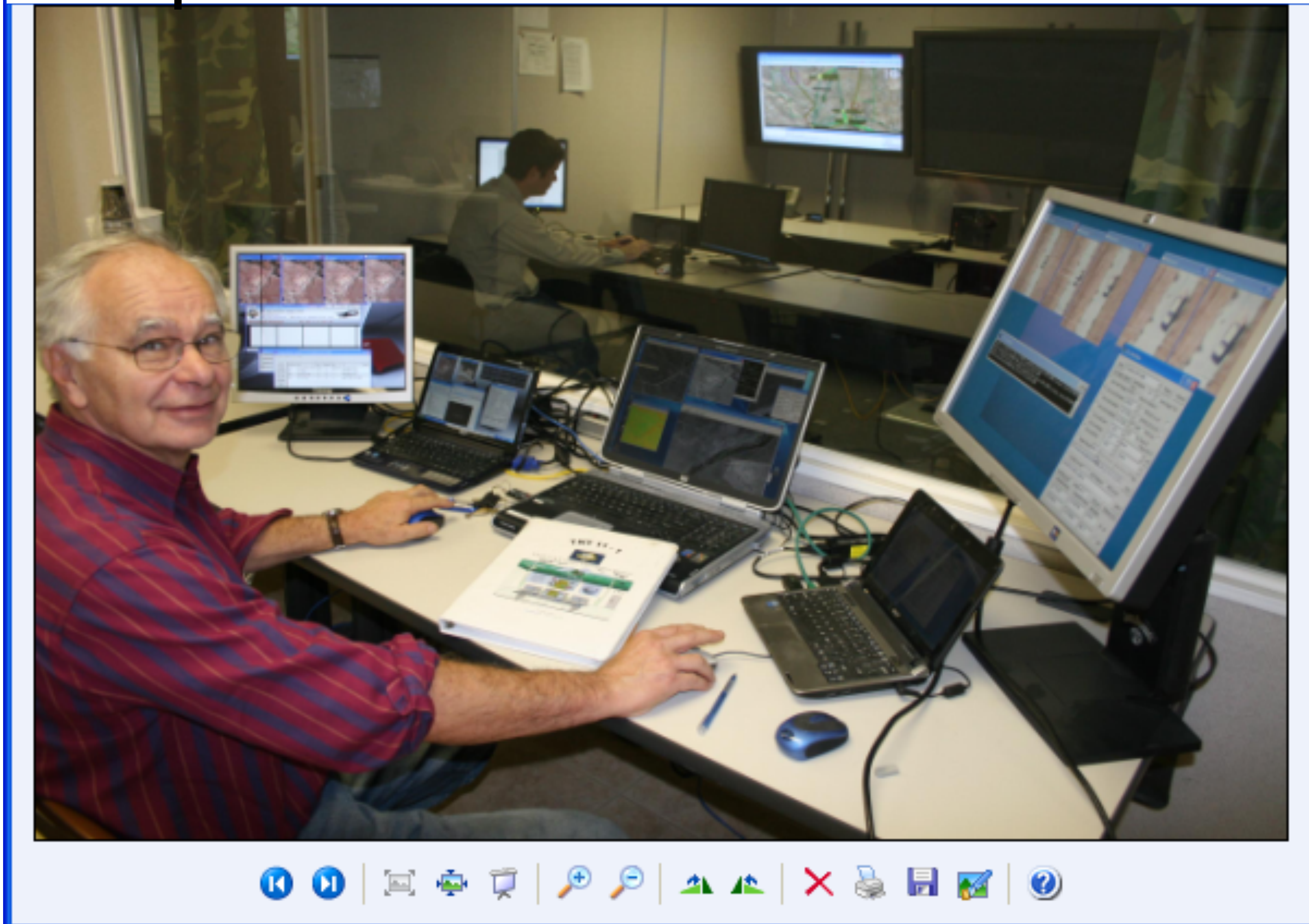


Reference Image in Measured Image Perspective

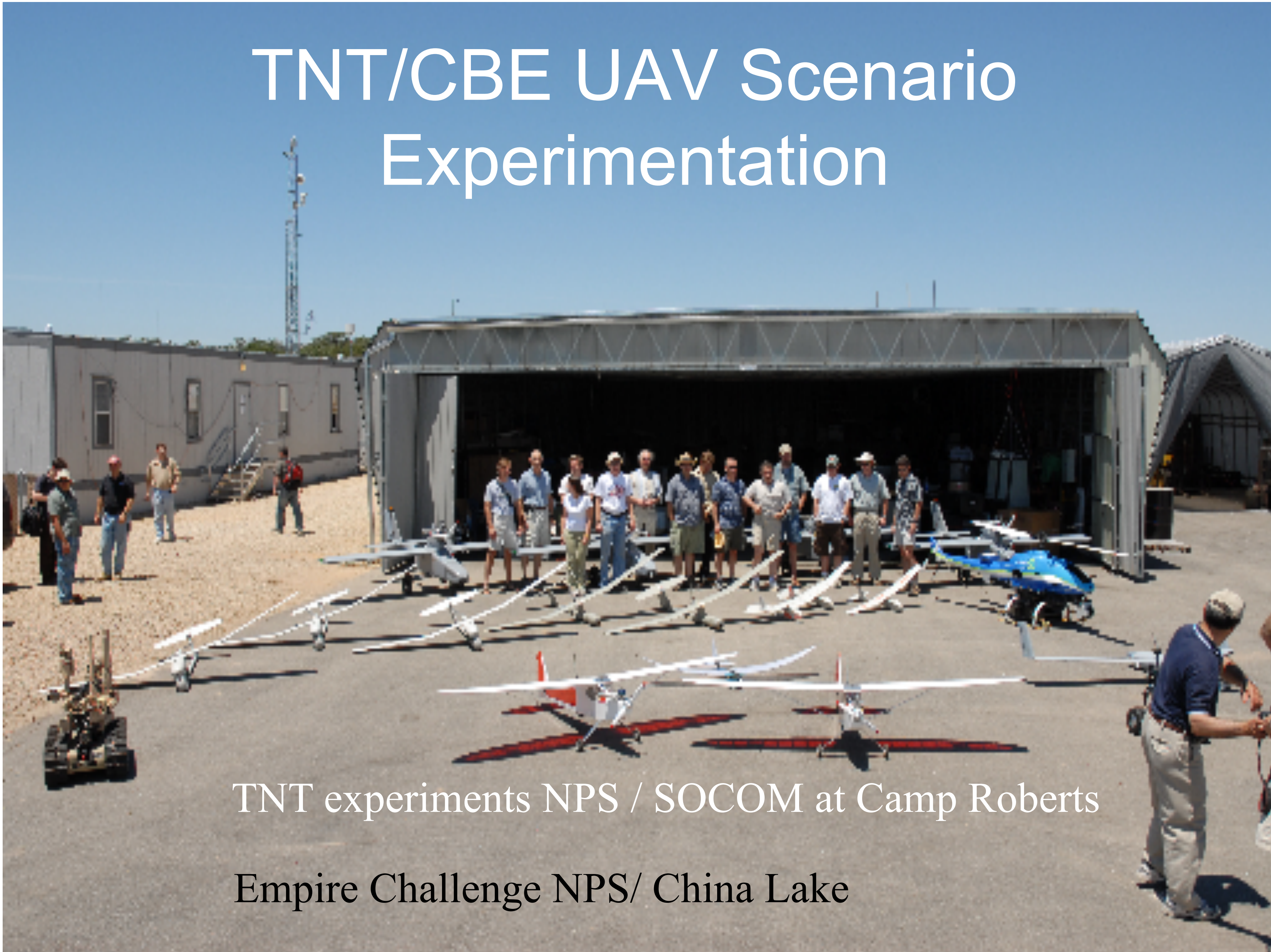
PVNT-Mission Control Station



PVNT-MCS in the Tactical Operations Center at TNT/CBE



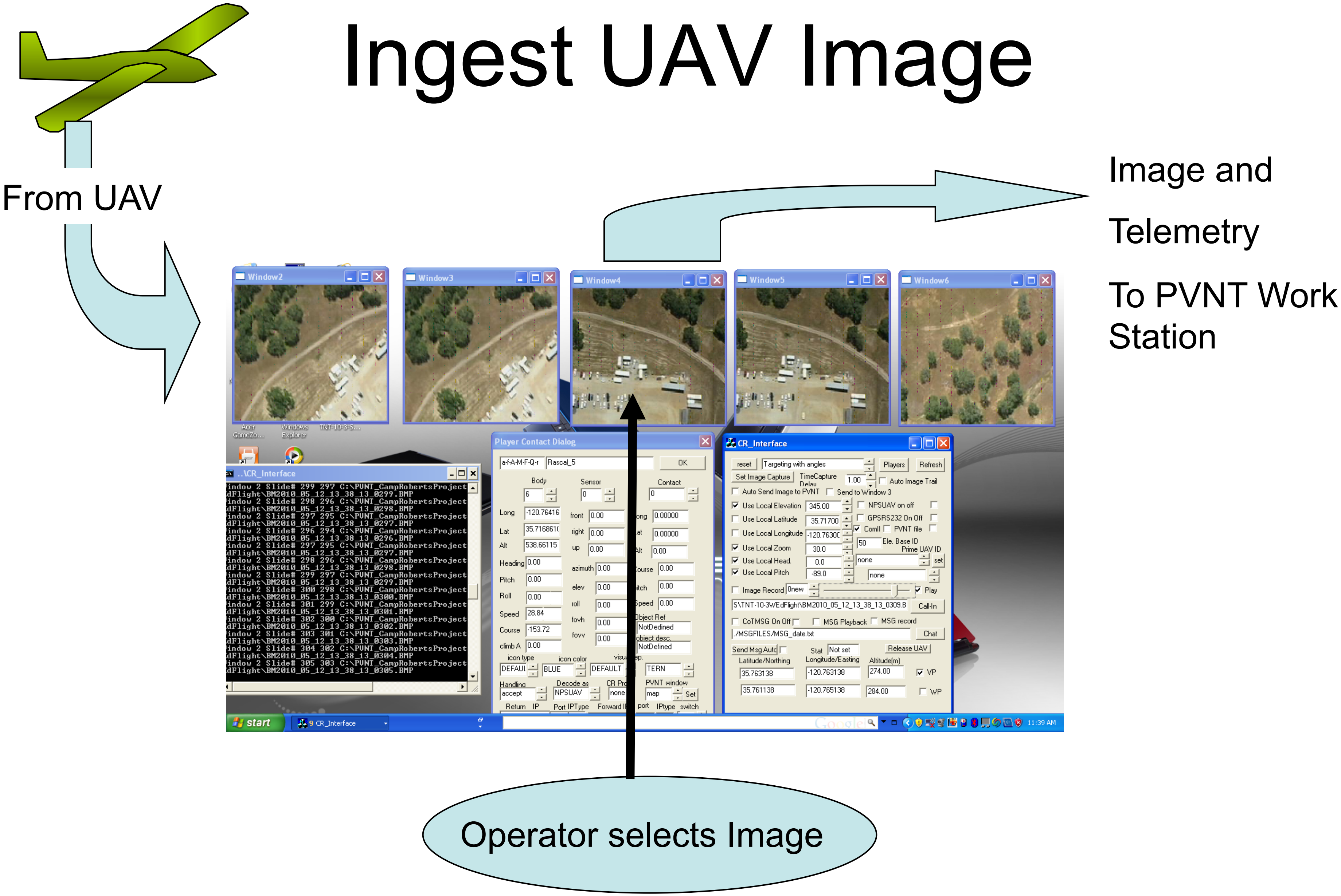
TNT/CBE UAV Scenario Experimentation



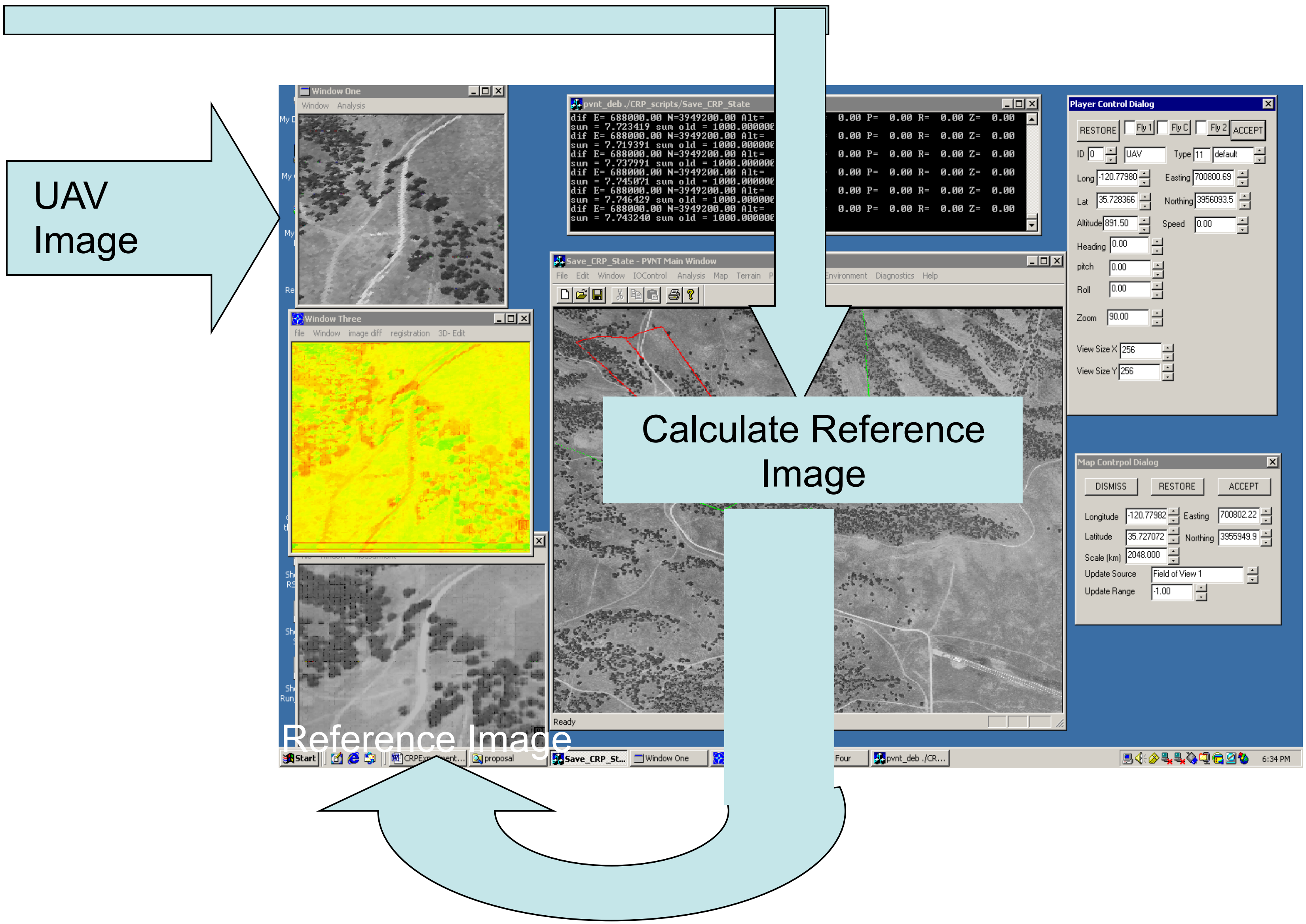
TNT experiments NPS / SOCOM at Camp Roberts

Empire Challenge NPS/ China Lake

Ingest UAV Image

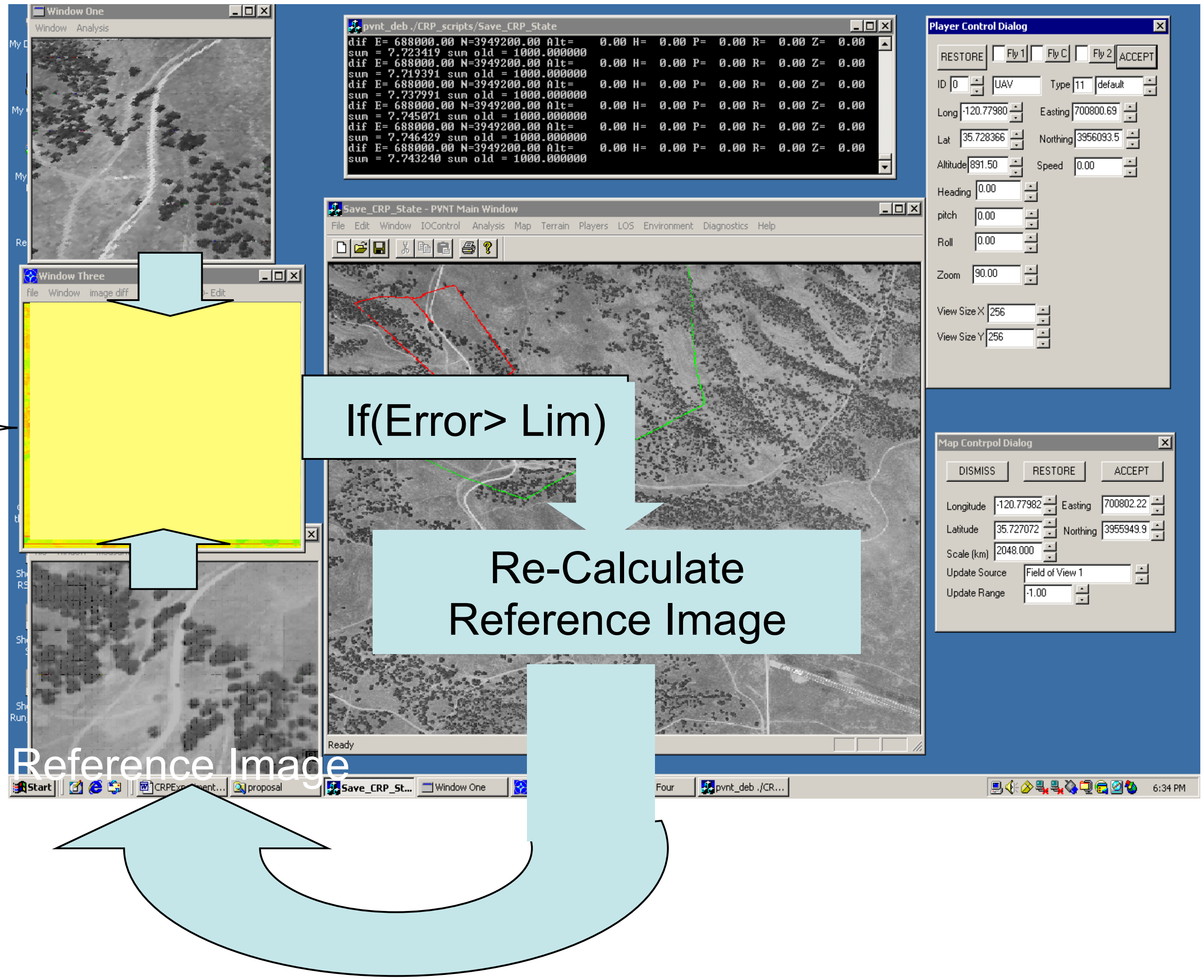


Calculate Reference Image

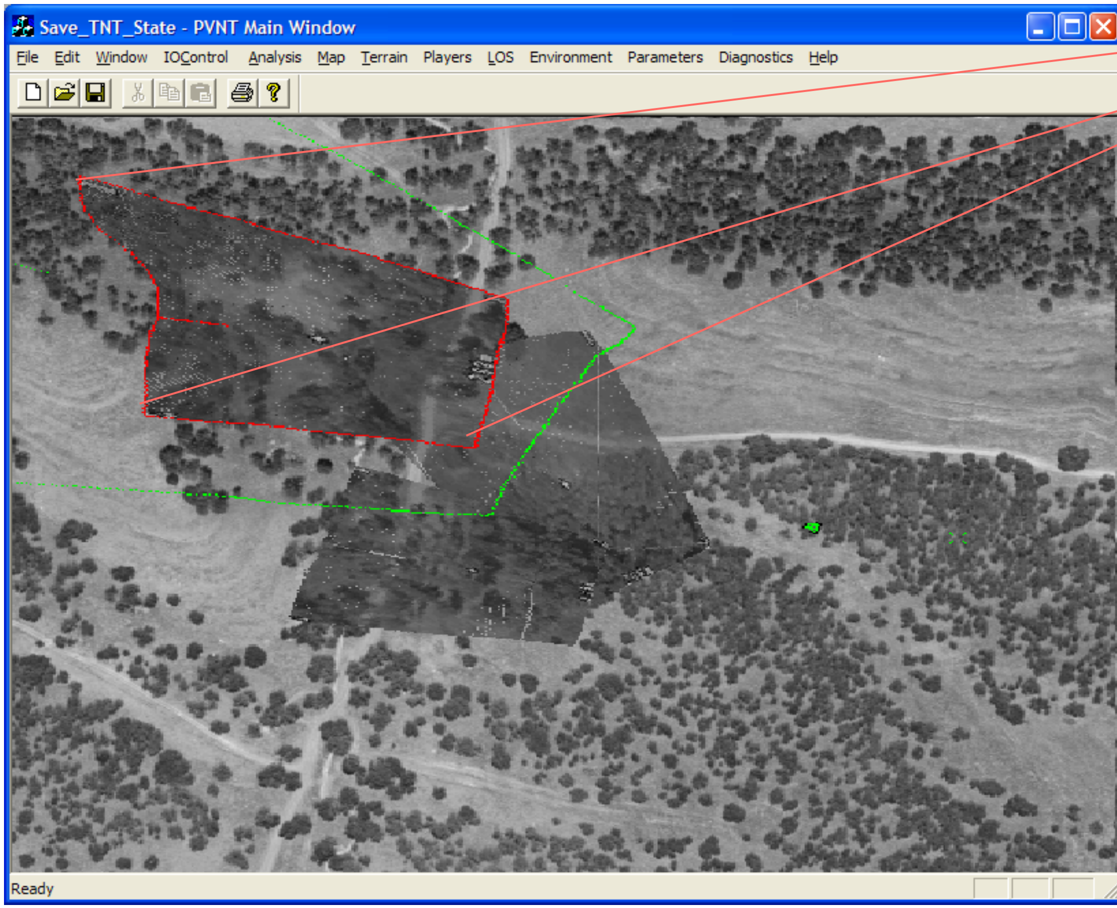


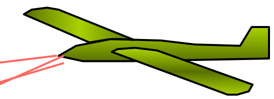
Register Image

When the Difference image is all yellow there is no error between the measured and calculated image



Automatic Ortho-rectification and Database Insertion





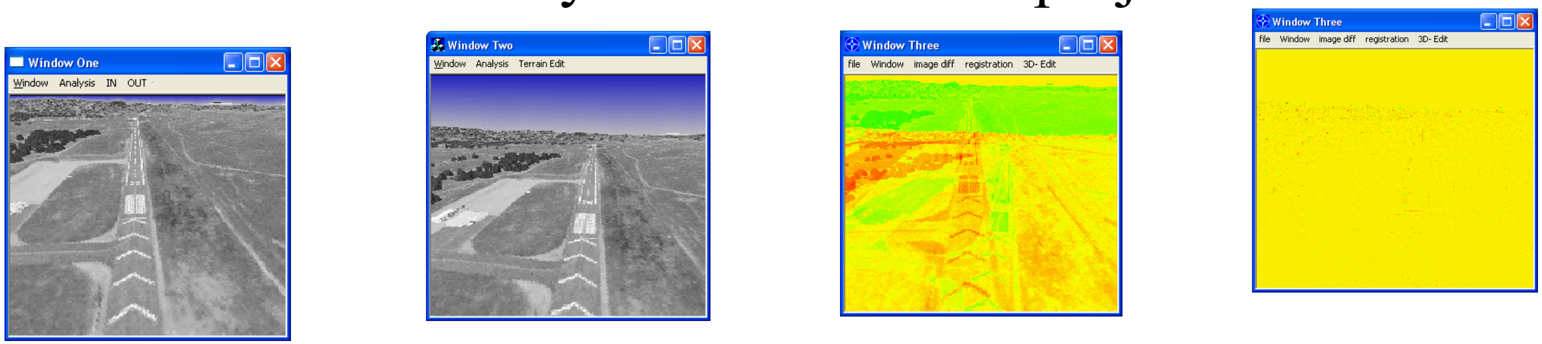
Ray trace algorithm of Reference image stores x,y,z location of all image points so ortho-rectifiction and terrain database insertion is reduced to a lookup and image transfer function.

Image Registration Bottleneck

Function	Time
• Image transmission and Ingest ()	Real time to 1sec/ frame
• Reference image generation	10-30 Fps
• Image Registration to 1 meter resolution	**Several Seconds to Minutes**
• Ortho-rectification	10-30 Fps
• Database storage	10-30 Fps

Automated Pixel Matching Method

- Works well when images are radio-metrically identical and the only difference is the projection



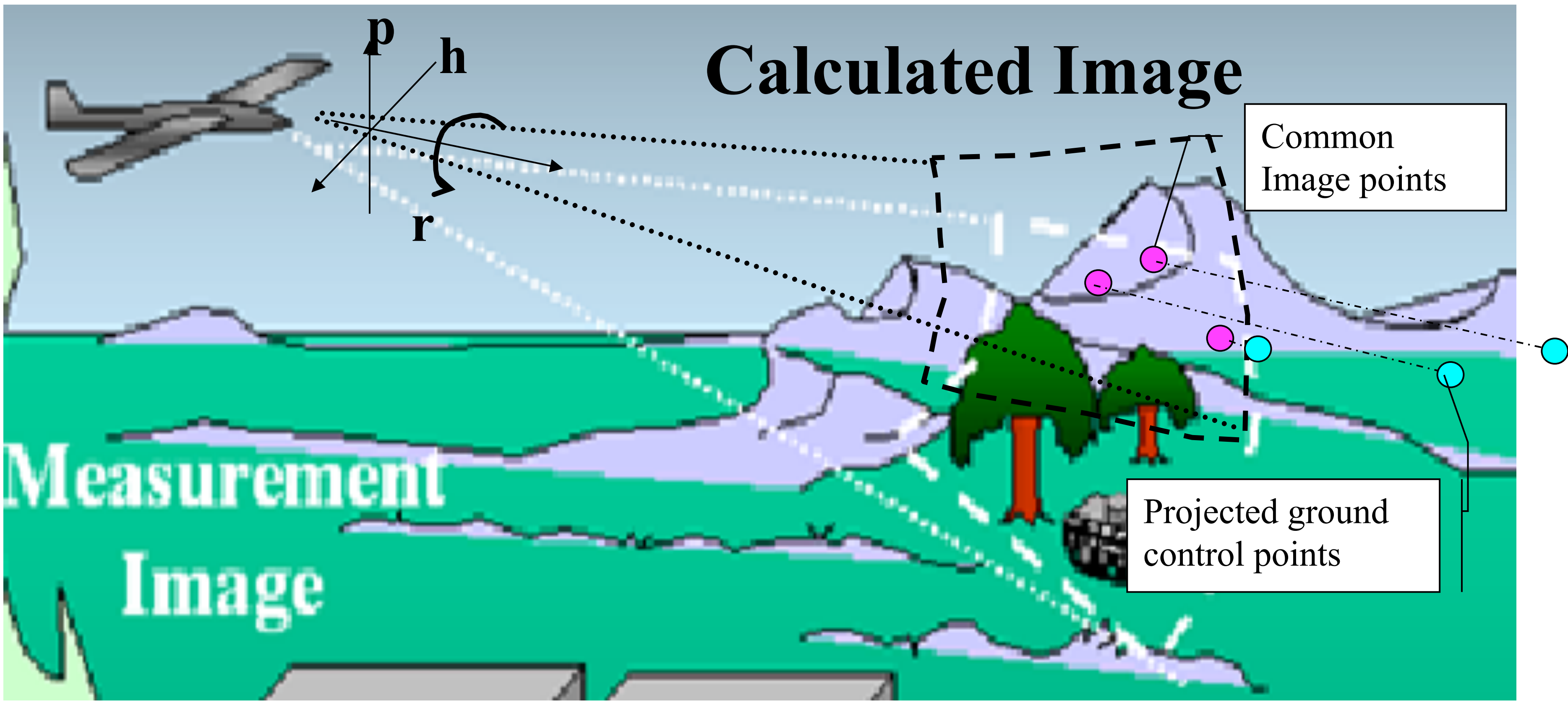
Calculated Registration	Measured Registration	Difference Before	Difference After
-74.19°h -21.19°	-63.00°h -35.50°p	11.19°h -14.31°p	-. 02°p -.03°p

Fig. 9 Registration of Two Radiometrically Identical Images

- Fails when measured and reference images differ due to environment, illumination, sensor modeling differences, database errors.

- Registering **different** images is our problem.

The classic Three or More Point Matching Method



Automatically selecting common image points accurately can be difficult in unstructured open terrain.

Interactive method

Still most reliable in an operational setting

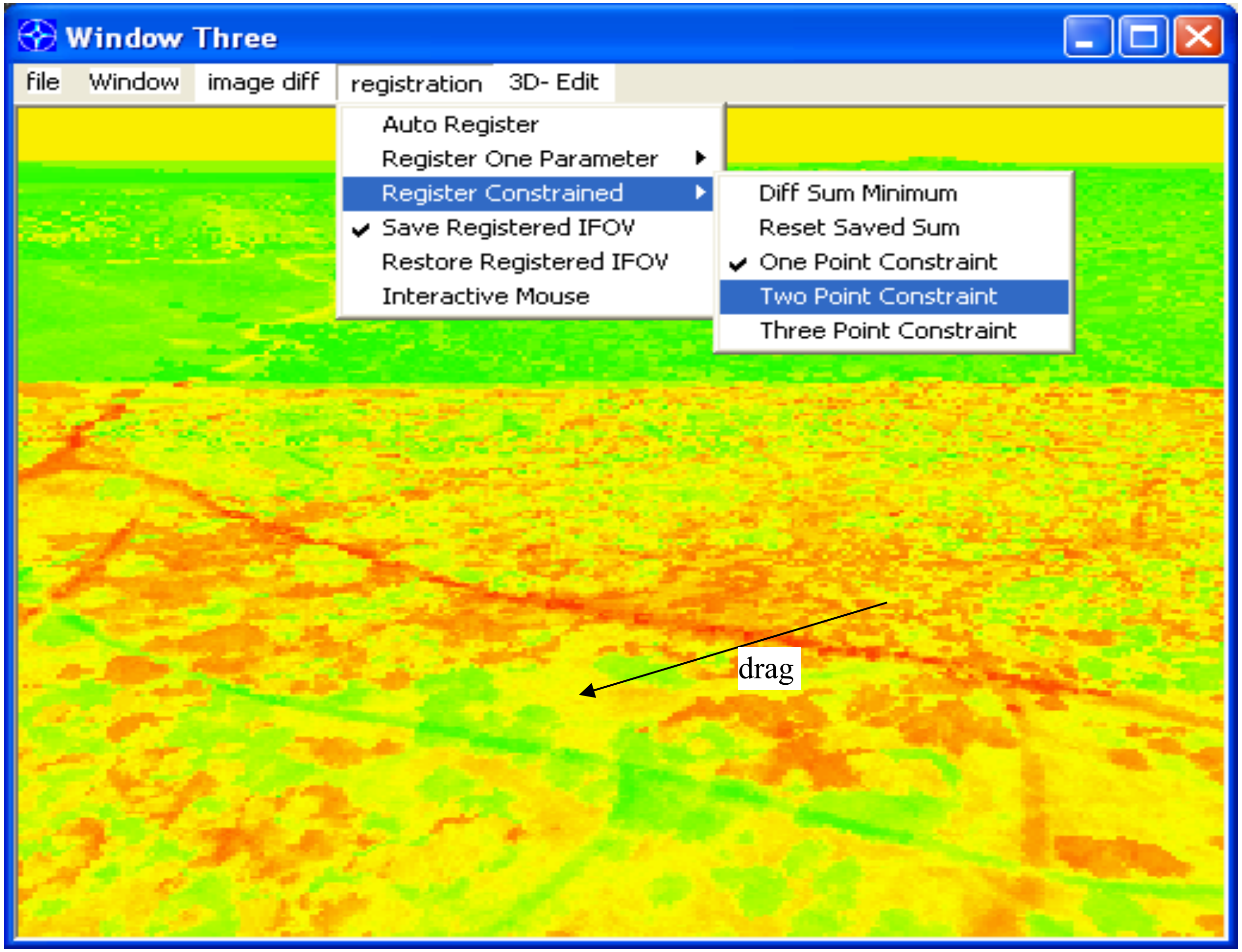
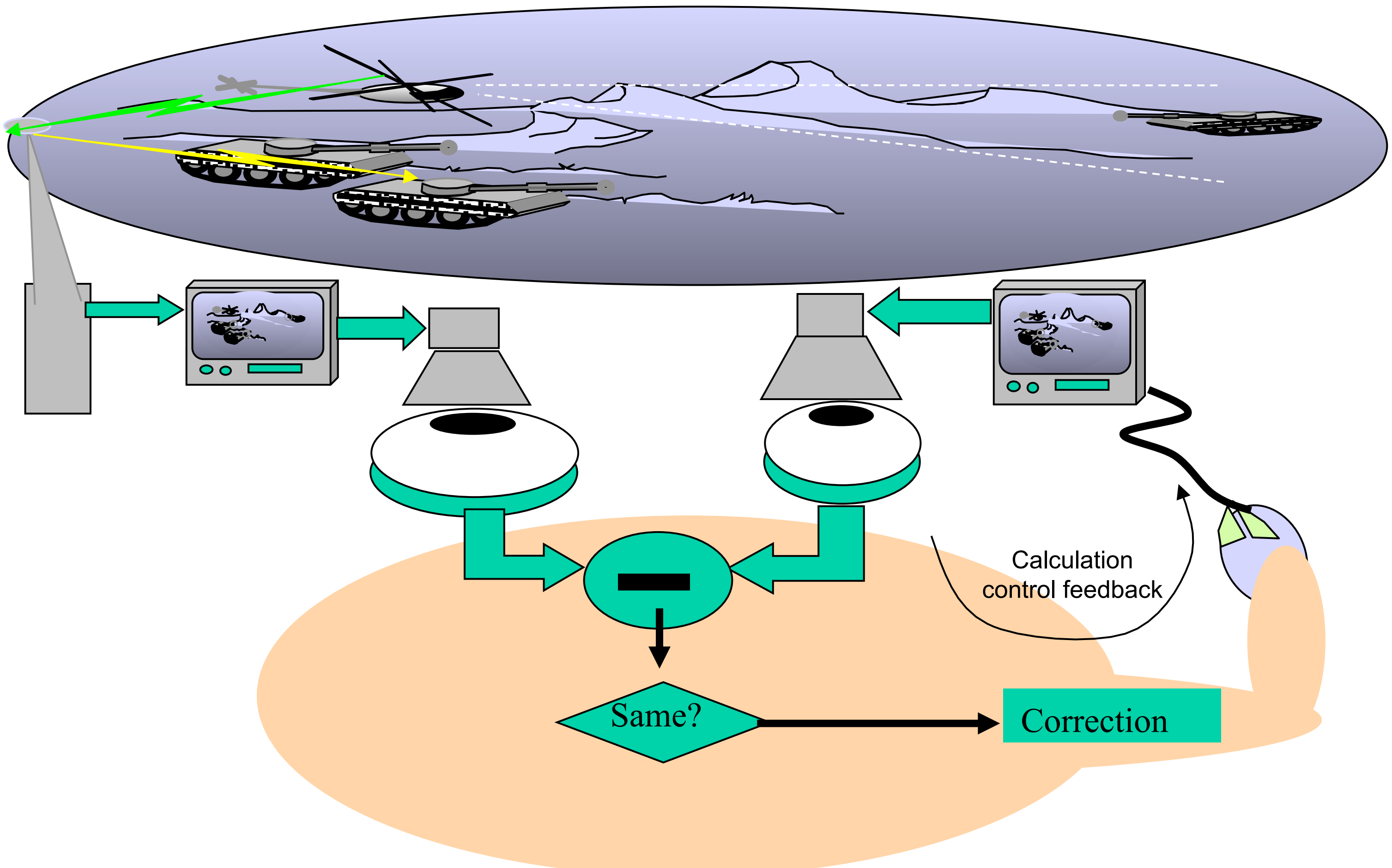


Fig. 8 Difference window with manual registration mouse commands

Interactive Camera Parameter Estimation

- Traditional 3 control and 3 measured point entry is a 6 click batch process
- Interactive Camera Parameter Estimation recalculates the best registration camera parameters after every entry
- Potentially reduces entry of registration data to one click
- Transferring Attention between two Images is fatiguing

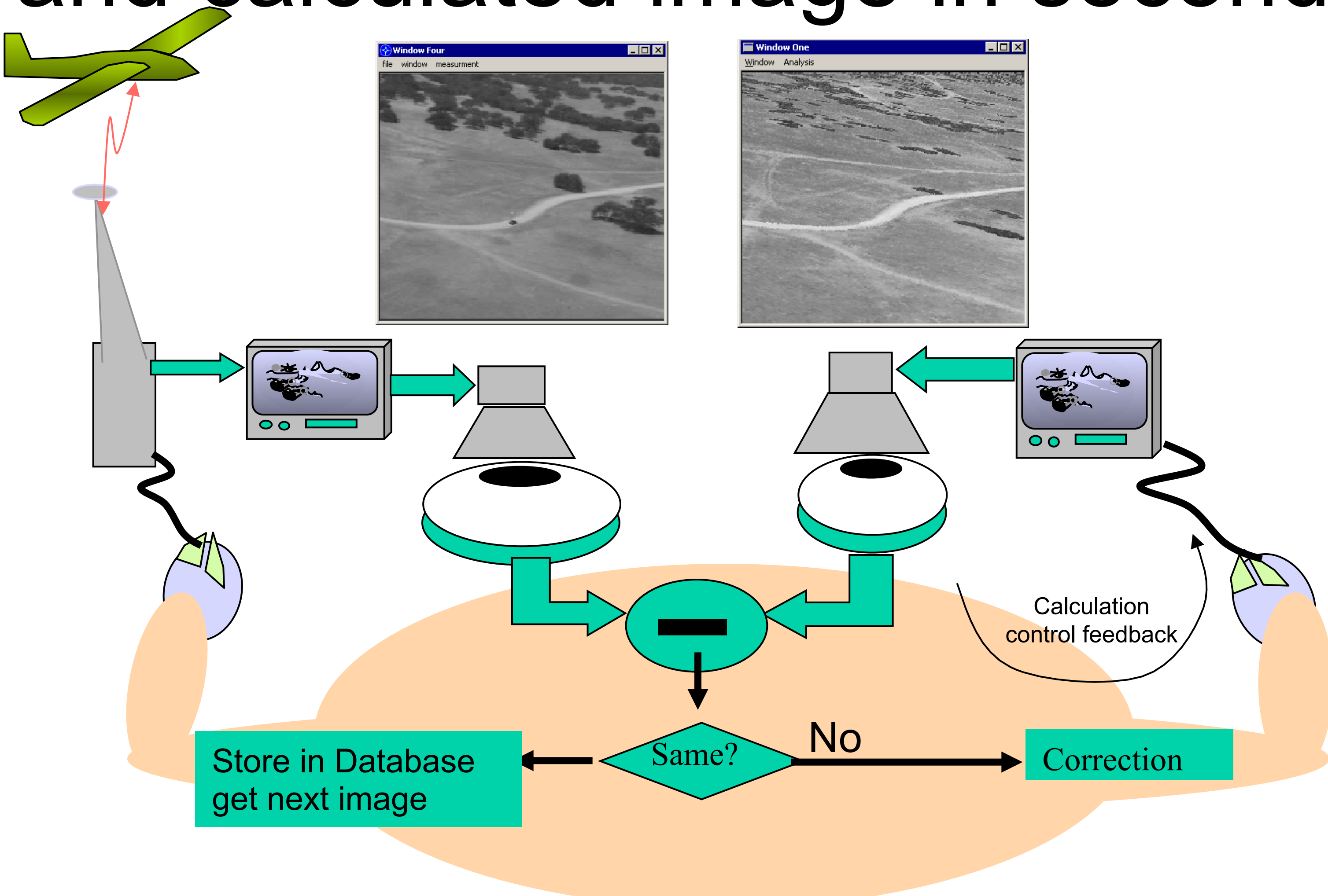
Live UAV Image Input in one eye and calculated image in second eye



Bi-scopic UAV image exploitation system setup

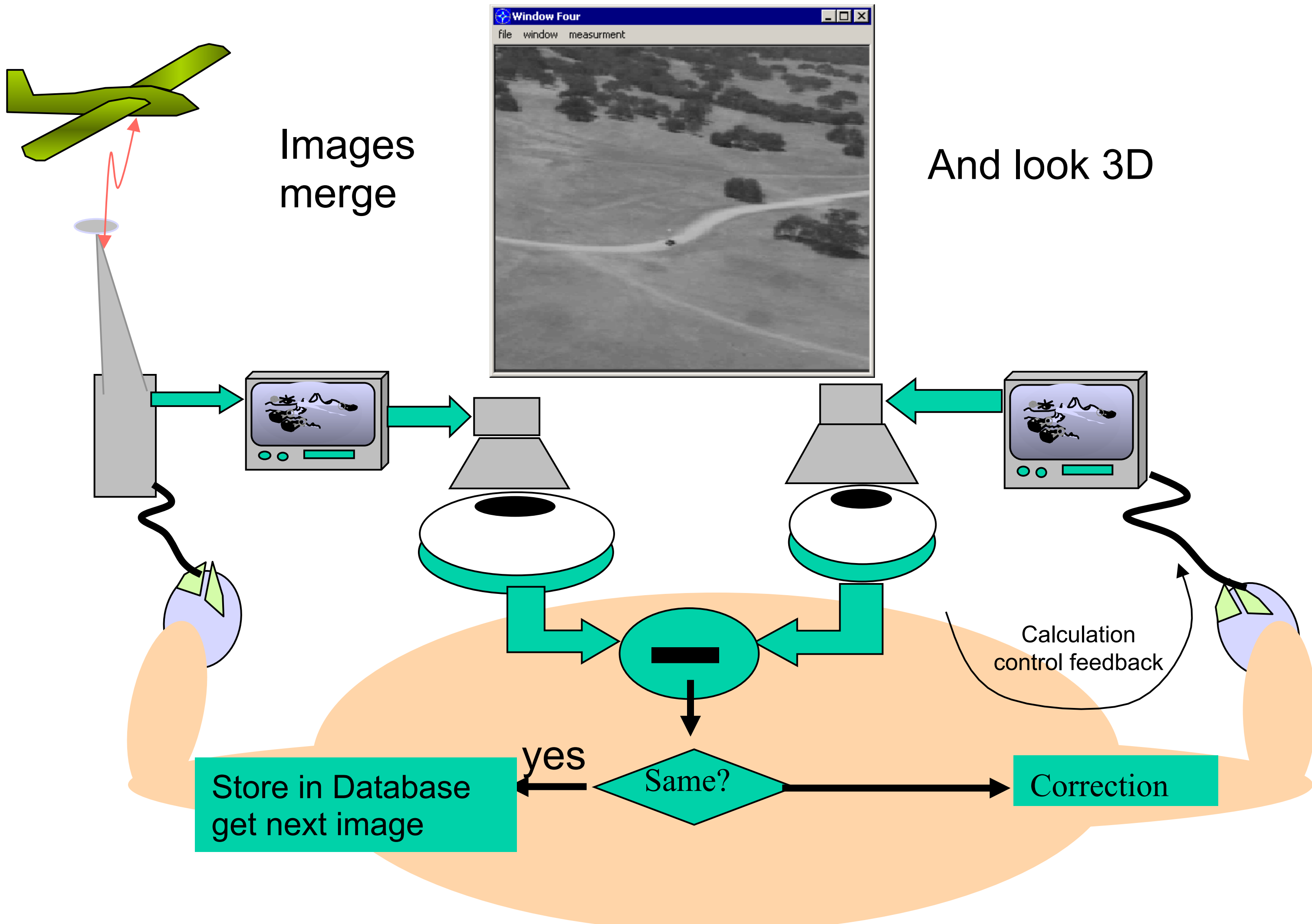
Author Wearing Dual Eye Input at Camp Roberts

Live UAV Image Input in one eye and calculated image in second eye



Bi-scopic UAV image exploitation system setup

When Stereo effect is Reached



Bi-scopic UAV image exploitation system setup

Terrain Generation Experiment Conclusion

- Automated image registration still requires human cognition for general open field applications
- Interactive registration can utilize each measured and control point to improve registration and minimize data entry load
- Dual –Eye input may provide a usefull interface for automated database insertion and UAV flight control

PVNT MCS Workstation Demo

- Conducted at 6Pm
- Watson Hall Rm 272
- Demonstrate
  - PVNT
  - Two Camp Roberts Interface Computers
  - Dual Eye Input display

Contact Information

- Prof. Wolfgang Baer Dep. of Information Science Code IS, Naval Postgraduate School, 1 University Circle, Monterey, CA 93943,
- Tel 831-656-2209 Baer@nps.edu

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